Remarks

Applicants respectfully request reconsideration of the present patent application in view of the above-amendments and following remarks. Claims 1, 6, 10 and 15 have been amended. No claims have been added or cancelled. Therefore, claims 1-19 are pending in the present application.

Claims 1, 10 and 15 have been amended to change "the catalyst" to "a catalyst" to provide proper antecedent basis, and to state that the starting temperature of the catalyst in the catalytic reformer is determined. *See Specification*, pg. 4, lines 27-28. Claim 6 has been amended to state that the fuel combustion time interval is at least dependent on a starting temperature of a catalyst in the reformer. *See Specification*, pg. 4, lines 27-28; pg. 6, lines 3-10.

Claims 6 and 7 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2002/0071974 to Yamaoka ("the Yamaoka reference"). The Yamaoka does not disclose the invention recited in the Applicants' claim.

Applicants' specification states: In order for a catalytic reformer to operate efficiently, a catalyst located within the reformer must be heated to a minimum temperature before reforming can begin. *See Specification*, pg. 1, lines 22-23. One method of heating the catalyst is using an inline combustor positioned upstream of the reformer, wherein a heated combustor exhaust is passed through the reformer. *See id.* at pg. 1, lines 22-26. It is of great importance to know when the catalyst surface reaches a temperature sufficient to support catalysis so that the fuel:air ratio may be switched from a fuel-lean mixture to a fuel-rich mixture, otherwise the fuel

cell system will be subject to reduced efficiency and durability. *See id.* at pg. 1, line 28 through pg. 2, line 5.

One method of determining when the catalyst has reached a minimum reforming temperature is to dispose a temperature sensor on the catalyst surface, however in practice this method is not particularly robust and may interfere with the flow of gases through the reformer. *See id.* at pg. 2, lines 6-9. Another method would be to dispose a temperature probe within the ceramic elements of the reformer, but this method would create hysteresis between the actual surface temperature and the measured temperature during a rapid temperature change within the reformer. *See id.* at pg. 2, lines 9-12. Yet another approach may be to empirically calculate the amount of time it would take for the surface of the catalyst to reach a minimum reforming temperature, and then change the air:fuel ratio after that period of time. *See id.* at pg. 2, lines 13-15. However, this method does not take into account the temperature of the catalyst upon start-up, and therefore the empirical calculation would be inaccurate if the catalyst is still warm from a previous period of operation. *See id.* at pg. 16-20. Neither a simple time instruction nor a catalyst internal measurement is adequate to determine when to change the enetering mixture from combustion to reforming. *See id.* at pg. 22-24.

The above-referenced deficiencies in the prior art methods of determining when the preheating of the reformer catalyst should cease is addressed by the invention set forth in amended independent claim 6. In particular, claim 6 is directed to a catalytic hydrocarbon reformer for making reformate comprising an electronic control module for controlling the flow of hydrocarbon fuel and air into the reformer.

The electronic control module is programmed with a software construct for determining a fuel combustion time interval for pre-heating the hydrocarbon catalytic reformer to a minimum reforming temperature. The fuel combustion time interval is at least dependent on a starting temperature of a catalyst in the reformer.

It is imperative to know the thermal status of the reformer when calculating the fuel combustion time interval. *See Specification*, pg. 5, lines 21-24; FIG. 2. Otherwise, as best seen in FIG. 2 of the present patent application, the changeover from a fuel lean condition to a fuel rich condition may happen too late (e.g., at 550°C instead of 500°C) thereby negatively impacting the durability of the catalyst and the potential for pre-ignition in the reformer will be increased. *See id.* at pg. 2, lines 3-5.

Applicants submit that the Yamaoka reference does not teach or suggest a catalytic hydrocarbon reformer including an electronic control module that is programmed with a software construct for <u>determining a fuel combustion time interval for pre-heating the hydrocarbon catalytic reformer to a minimum reforming temperature, wherein the fuel combustion time interval is at least dependent on a starting temperature of a catalyst in the reformer</u> as recited in claim 6. In rejecting claim 6, the Examiner acknowledged that the Yamaoka reference does not disclose the step of determining a fuel combustion time interval for pre-heating a reformer. *See Office Action mailed on September 4, 2008* ("Office Action"), pg. 4. However, the Examiner stated that it would have been obvious to "measure the time necessary [to heat] the raw fuel to a reformer temperature to compensate for the time necessary for the process to occur given the quantity of the fuel used and target temperature desired." *Office Action*, pg. 4, ¶ 9.

Given that the Examiner's statement set forth above is specifically directed to measuring the "time necessary [to heat] the raw fuel to a reformer temperature," it appears that the Examiner is misinterpreting the language of claim 6. The language of claim 6 does not relate to determining how long it will take to heat the raw fuel to a reforming temperature, but instead relates to determining the amount of time that combustion must take place in order <u>to pre-heat the catalytic reformer to a minimum reforming temperature</u>. The amount of time that it will take to heat the raw fuel to a reforming temperature does not necessarily correlate to the amount of the time it will take for the catalytic reformer to reach a minimum reforming temperature. The time intervals for heating the raw fuel compared to heating the catalytic reformer may be based on independent factors. For example, the composition of the raw fuel and the reformer catalyst are different and therefore will heat up at different rates. In addition, the starting temperatures of the reformer catalyst and the raw fuel prior to heating may be different. Therefore, Applicants submit that a time interval for heating raw fuel to a reformer temperature, as proposed by the Examiner, is not equivalent to a fuel combustion time interval for pre-heating a catalytic reformer to a minimum reforming temperature as set forth in claim 6.

In support of the rejection of claim 6, the Examiner has cited to paragraphs [0010] and [0015], as well as FIG. 6 of the Yamaoka reference. None of these portions of the Yamaoka reference suggest that that the fuel combustion time interval in claim 6 is dependent upon <u>a starting temperature of a catalyst within the reformer</u>. Paragraph [0010] of the Yamaoka reference states that a heating device is used to heat raw fuel to a predetermined target temperature, and a raw fuel

quantity determinator is used to determine the amount of raw fuel that is supplied to the heating device. *See Yamaoka*, ¶ [0010]. Further, paragraph [0010] of the Yamaoka reference states that a target temperature setting means operates to set the target temperature of the raw fuel on the basis of the quantity of the raw fuel that is supplied to the heating device. *See id.* The Yamaoka reference also states that if the quantity of the raw fuel supplied to the heating device increases, the target temperature for the raw fuel also increases. *See id.* at ¶ [0011]; *see also* ¶ [0043] (stating that the quantity of the raw fuel passing through the heating device is dependent upon the load of the fuel cell).

In view of paragraphs [0010] and [0011] of the Yamaoka reference, Applicants submit that the "target temperature setting means" and the "quantity determinator" mentioned by the Examiner in the Office Action do not relate to a fuel combustion time interval that is dependent on a starting temperature of a catalyst within the reformer as recited in claim 6. As mentioned above, the quantity determinator determines the quantity of raw fuel flowing through the heating device, and the target temperature setting means sets the target temperature of the raw fuel within the heating device based on the determined quantity of raw fuel. Neither of these components within the Yamaoka reference relates to a starting temperature of a catalyst within the reformer.

Paragraph [0015] of the Yamaoka reference relates to a detector for detecting a physical value indicating the quantity of the raw fuel heated by the heating device, and a correcting means for correcting the target temperature based on the physical value detected by the detector. *See Yamaoka*, ¶¶ [0014], [0015]. Neither the

detector nor the correcting means have anything to do with determining a fuel combustion time interval that is dependent upon a starting temperature of a catalyst within the reformer, as set forth in claim 6. The detector merely operates to measure the actual quantity of raw fuel passing through the heating device, which does not relate to the starting temperature of a catalyst within the reformer. The correcting means adjusts the target temperature for the raw fuel based on the actual measured value, which also does not relate to the starting temperature of a catalyst within the reformer.

The two graphs shown in FIG. 6 of the Yamaoka reference also do not suggest a fuel combustion time interval for pre-heating a hydrocarbon catalytic reformer. Instead, FIG. 6 discloses "a correction value of a quantity of fuel for burning at a transient time when a quantity of raw fuel changes as a step function." *Yamaoka*, ¶ [0023]. In other words, the graphs in FIG. 6 of the Yamaoka reference relate to a circumstance where the amount of raw fuel passing through the vaporizing device (7) increases due to, for instance, an increase in load applied to the fuel cell. *See id.* at ¶ [0043]. Given the increased flow of raw fuel passing through the vaporizing device (7), the target temperature of the raw fuel will also increase. *See id.* at ¶¶ [0010], [0011]. In order to increase the temperature of the raw fuel flowing through the vaporizing device (7), the amount of raw fuel injected into the burning device (6) will also need to be increased. *See id.* at ¶ [0027]. Therefore, the graphs shown in FIG. 6 of the Yamaoka reference relate to introducing a correction value of raw fuel for burning in the burning device (6) as the quantity of raw fuel passing through the vaporizing device (7) changes, which does

not suggest that a fuel combustion interval is determined based on a starting temperature of a catalyst within the reformer.

For at least the reasons set forth above, Applicants submit that there has been no evidence to conclude that the Yamaoka reference discloses a fuel combustion time interval that is dependent upon a starting temperature of a catalyst within the reformer. As such, a prima facie case of obviousness has not been established based on the Yamaoka reference. Applicants request that the rejection of claim 6 be withdrawn. As claim 7 depends from claim 6, it is requested that the rejection of claim 7 be withdrawn as well.

Claims 1-5 and 10-19 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2003/0101713 to Dalla Betta ("the Dalla reference") in view of the Yamaoka reference.

Amended independent claim 1 is directed to a method for pre-heating a hydrocarbon catalytic reformer from a starting temperature to a minimum reforming temperature utilizing an electronic control module, comprising the steps of: a) selecting a fuel type to be combusted; b) determining the latent heat of combustion of the selected fuel type; c) selecting a flow rate of the combustion fuel; d) determining the heat capacity of a catalyst to be heated in the catalytic reformer; e) determining a mass of the reformer to be heated; f) determining a starting temperature of the catalyst in the catalytic reformer; g) utilizing a software construct to produce the fuel combustion time interval, wherein the construct utilizes the latent heat of combustion, the selected combustion fuel flow rate, the heat capacity of the catalyst, the mass to be heated, and the starting temperature; and h) pre-heating the

hydrocarbon catalytic reformer using a combustor for the fuel combustion time interval so that the hydrocarbon catalytic reformer reaches the minimum reforming temperature.

Applicants submit that the combination of the Dalla reference and the Yamaoka reference do not teach or suggest a method for pre-heating a hydrocarbon catalytic reformer comprising the steps of: <u>f) determining a starting temperature of a catalyst in a catalytic reformer; and g) utilizing a software construct to produce a fuel combustion time interval based on, among other factors, the starting temperature of the catalyst of the catalytic reformer</u> as recited in amended claim 1. In rejecting claim 1, the Examiner stated that the Dalla reference discloses the use of an initial temperature for use in preheating to a minimum reforming temperature. *See Office Action*, pg. 4 (citing paragraph [0095] of the Dalla reference). Paragraph [0095] of the Dalla reference states that the fuel flow rate to the fuel processor may be a function of <u>the exhaust temperature at the fuel processor inlet</u>. *See Dalla*, ¶ [0095]. In contrast, step f) included in amended claim 1 relates to determining a starting temperature of <u>a catalyst in a catalytic reformer</u>. The different starting temperatures of the exhaust at the fuel processor inlet and the catalyst in the catalytic reformer would result in different fuel combustion time intervals. Any variance in the fuel combustion time interval calculated by using the exhaust temperature at the fuel processor inlet could result in a reduction in efficiency and durability of the fuel cell assembly. *See Specification*, pg. 1, line 28 through pg. 2, line 5. It is therefore submitted that the Dalla reference does not teach or suggest the step of determining a starting temperature of a catalyst in a catalytic reformer as set forth in claim 1.

In the Office Action, the Examiner stated that the Dalla reference's "disclosure of calculating the length of time of fuel reforming in rich mode (paragraph 101) does not preclude the significance and ability of [the Dalla reference] to implicitly calculate combustion time." *Office Action*, pg. 2, ¶ 4. Whether or not applicants agree with the Examiner's statement, the burden still falls on the Examiner's to show how paragraph [0101] of the Dalla reference necessarily discloses that a starting temperature of the catalyst in the catalytic reformer is used to produce a fuel combustion time interval so that the reformer reaches a minimum reforming temperature. Applicants maintain that the fuel processing referred to in paragraph [0101] is not related to the length of time that the fuel is combusted to heat the reformer (i.e., fuel combustion time interval), but is instead related to the length of time the fuel processor (reformer) is operated in a "rich mode," which relates to a reforming mode. *See Specification*, pg. 1, lines 26-28 (stating that a reformer operates in a fuel rich condition and a combustor operates in a lean fuel to air ratio). Paragraph [0101] does not provide any evidence to conclude that a starting temperature of the catalyst in the fuel processor (i.e., reformer) is taken into consideration when determining how long to use a combustor to pre-heat the reformer to a minimum reforming temperature.

The Examiner also relies on paragraph [0095] of the Dalla reference to show that the amount of fuel that is fed to the reformer is calculated by integrating with respect to time, and therefore calculating time when fuel rate is known would be a known calculation. *See Office Action*, pgs. 2, ¶ 4. While the above rationale addresses the calculation of time for feeding fuel to a reformer, it does not in any

way address the calculation of a fuel combustion time interval during which a combustor operates to pre-heat the reformer to a minimum reforming temperature, as recited in claim 1. Further, the Examiner's rationale also does not address how the alleged time interval for feeding fuel to the reformer in paragraph [0095] relates to the starting temperature of the catalyst in the catalytic reformer. The cited portions of the Dalla reference relate to calculating the fuel flow to a reformer, while claim 1 relates to calculating a fuel combustion time interval for a combustor to pre-heat the reformer to a minimum operating temperature.

The Examiner also cites paragraph [0093] to support the above position. *See Office Action*, pg. 2, ¶ 4. Applicants submit that paragraph [0093] relates to a nitrogen oxides storage-reduction ("NSR") emission control system, and does not relate to the production of a fuel combustion time interval based on the starting temperature of a catalyst in a reformer. *See also Dalla*, Abstract; FIG. 1.

In rejecting claim 1, the Examiner acknowledges that the Dalla reference does not disclose the details of the software construct set forth in step g) of claim 1, and therefore combines the Yamaoka reference with the Dalla reference. *See Office Action*, pg. 5. Applicants submit that the Yamaoka reference fails to teach or suggest the step recited in step g) of claim 1 for at least the same reasons that were set forth above with respect to claim 6.

For at least the foregoing reasons, Applicants submit that a prima facie case of obviousness has not been established with respect to claim 1, and request that the rejection of claim 1 be withdrawn. As claims 2-5 depend from claim 1, these

claims are not taught or suggested by the combination of the Dalla and Yamaoka references for at least the same reasons that were set forth with respect to claim 1.

Since claims 10-19 also include limitations that are similar to those that were argued above with respect to claim 1, Applicants submit that claims 10-19 are not taught or suggested by the combination of the Dalla and Yamaoka references for at least the same reasons that were set forth with respect to claim 1. It is requested that the rejection of claims 10-19 be withdrawn.

Claim 8 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over the Yamaoka reference in view of the Dalla reference. Since claim 8 depends from claim 6, Applicants submit that the Yamaoka reference fails to teach or suggest all of the limitations included therein for at least the same reasons that were set forth above with respect to claim 6. The Dalla reference also fails to teach or suggest the limitation that was lacking in the Yamaoka reference. It is therefore requested that the rejection of claim 8 be withdrawn.

Claim 9 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over the Yamaoka reference in view of U.S. Patent Publication No. 2002/0150532 to Grieve ("the Grieve reference"). Since claim 8 depends from claim 6, Applicants submit that the Yamaoka reference fails to teach or suggest all of the limitations included therein for at least the same reasons that were set forth above with respect to claim 6. The Grieve reference also fails to teach or suggest the limitation that was lacking in the Yamaoka reference. It is therefore requested that the rejection of claim 8 be withdrawn.

Conclusion

In light of the foregoing, Applicants submit that claims 1-19 are in condition for allowance and such allowance is respectfully requested. Should the Examiner feel that any unresolved issues remain in this case, the undersigned may be contacted at the telephone number listed below to arrange for an issue resolving conference.

Applicants do not believe that any fee is due at this time. However, the Commissioner is hereby authorized to charge any fees that may have been overlooked to Deposit Account No. 50-4635.

Respectfully submitted,

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